resistance) if the speed of pulling is such that the spools 72a, 72b are rotating at a rotational rate faster than that of the current rotational rate of the shaft 83. The linear speed of the rope ends 75a, 75b, 77a, 77b is related to rotational rate of the spools 72a, 72b by the spool diameter. In the depicted embodiment, the spools 72a, 72b are each provided with two separate stepped diameters. Thus, the user may, if desired, adjust the ratio of arm resistance to leg resistance by causing the lines 68a, 68b to be spooled onto or off of the smaller-diameter sections of the spools 72a, 72b. In one embodiment, this can be done by pulling each rope 68a, 68b until it is completely unwound from the spools 72a, 72b and rewrapping it under manual guidance, on a different portion of the spool with a different diameter. The same effect could be achieved using a bicycle-type derailleur to automatically shift the ropes from one diameter section to another. Although in the depicted embodiment only two diameters of spool are shown, three or more could be provided if desired, or a single diameter could be provided. It is also possible to couple the spools 72a, 72b to the driveshaft 83 via a linkage such as a chain drive, belt drive, gear train or the like, which could be provided with changeable transmissions for changing the effective ratio and thus the relative resistance to arm exercise.

In use, the exerciser can choose to manually control the motor speed, e.g., via a manual potentiometer knob or other adjustment, or can rely on the speed controller described above for automatic adjustment. The user steps onto the footcars 50 and, beginning at the rearmost position, typically, starts an alternating "walking" type motion. Initially, the conveyor belts are stopped and thus the wheels with the one way clutches on the foot cars allow the cars to slide forward but not backward. As a result, the user moves towards the front of the machine. As the user moves forward, the speed control circuit, as described above, causes the motor 53 to begin driving the belts. As the user approaches the front of the machine, the user may, if desired, grasp the hand grips 75a, 75b or 77a, 77b, preferably continuing the walking motion. As the motor begins to move the conveyor belts, the user's position is changed relative to the frame of the exerciser and the speed control circuit, described above, continually adjusts the speed of the conveyor belts to the user's stride.

Preferably the rails 79 can be pivoted so that they can be folded out of the way as depicted in Fig. 5 or extended as in depicted in Fig. 5A for use. To adjust the position of the rails 79 adjust knobs 82 (Fig. 9) are loosened to allow rail support 80 to slide freely. When the rails 79 are positioned in the desired location, the knobs 82 are tightened to hold the rails in the desired position.

Fig. 10 depicts a procedure that can be used for adjusting the speed of motor 53. In one embodiment the procedure depicted in Fig. 10 is implemented using a microcontroller for controlling the motor. In the embodiment of Fig. 10, it is preferred that if the user is more than a predetermined distance aft (such as five feet or greater from the front of the machine) 1012, the belts 522 will be immobile, i.e., the motor speed will be set to zero 1014. Similarly, if at any time the distance of the user from the front of the machine changes at a rate of greater than one

foot per second for greater than 1.5 feet 1016, the belts are similarly stopped by setting the motor speed to zero 1018. The procedure preferably differs somewhat depending on whether the machine is in start-up mode (e.g., after the user initially mounts the machine) or is in normal or run mode.

Preferably, the unit will not start unless the range (i.e., the distance of the user from the front of the machine) is less than a predetermined amount such as two feet 1022. If the user is not in this range, the procedure loops 1024 until the user moves within range. Once the user has moved within range, the machine is initially in start-up mode and the speed is set to a predetermined initial speed such as 25% of maximum speed 1026. In one embodiment, the controller will ramp up a speed gradually so that the output from the microcontroller board can go immediately to 25% upon start-up. Assuming the maximum velocity condition has not been exceeded 1016, if the range stays below three feet 1028 within three seconds 1032 while the device is in start-up mode 1034 the speed will increase by 10% 1036 each second 1038, looping 1042 through this start-up procedure 1044 until the user exceeds a range of three feet 1028. Once the user exceeds a range of three feet from the front of the machine 1028, i.e., is within the range of three feet to four feet 1046, the motor speed 53 will be maintained 1048 and the machine will thereafter be considered to be in run mode 1052.

In general, the speed of the machine will be maintained constant whenever the user is in a predetermined range such as three to four feet 1046. Once the device is out of start-up mode, in general, the procedure will decrease motor speed if the position exceeds four feet or increase motor speed if the range falls below three feet, (until such time as the user exceeds a predetermined maximum range 1012 or a predetermined speed 1016). In the depicted embodiment, if the range goes to 4.1 to 4.3 feet 1054 the speed will be decreased by five percent 1056 every second 1058 until the range is back to three to four feet 1046 at which point the present speed will be maintained 1048. If the range goes to 4.4 to 4.6 feet 1062 the speed will be decreased by 10 percent 1064 every half second 1066 until the range is back to three to four feet 1046. If the range goes to 4.7 to 4.9 feet 1068 the speed will be decreased by 20 percent 1072 every half second 1074 until the range is back to three to four feet. If the range exceeds five feet 1012, the motor speed will be set to zero 1014 and the unit will not start again until the range is less than two feet 1022. If the range goes to 2.9 to 2.7 feet 1076 the speed will be increased by five percent 1078 every second 1082 until the range is back to three to four feet. If the range goes to 2.6 feet or less 1084 the speed will be increased by 10 percent 1086 every half second 1088 until the range is back to three to four feet or full speed is attained, at which point present speed will be maintained. As will be clear to those of skill in the art, the number of categories of speed, the amount of increase in speed and the rate at which speed increments are added can all be varied. Additionally, it is possible to define motor speed as a continuous function of position, rather than as a discrete (stepwise) function. Other types of control can be used such as controls which automatically vary the speed at predetermined times, or in predetermined circumstances, e.g., to simulate different

snow or terrain conditions, controls which automatically raise or lower the elevation 528, 542 to simulate variations in terrain and the like.

In light of the above description a number of advantages of the present invention can be seen. The present invention more accurately simulates natural exercise then many previous devices. In one embodiment the device provides resistance to forward or upward leg movement rather than only rearward leg movement. Preferably forward leg movement resistance can be adjusted. Preferably the device controls the speed and/or resistance offered or perceived and, in one embodiment speed is controlled in response to the fore-aft location of the user on the machine. In one embodiment, the fore-aft location is detected automatically and may, in some embodiments, be detected without physically connecting the user to the machine, e.g., by a clothing clip or otherwise. The device is capable of providing upper body exercise, preferably such that, as a user maintains a given level of overall effort, expenditure of greater lower body effort permits expenditure of less upper body effort and vice versa. Preferably the arm exercise is bilaterally independent such that user may exercise left and right arms alternately, in parallel, or may exercise only one or neither arm during leg exercise.

A number of variations and modifications of the present invention can be used. In general, the described method of speed control (preferably involving automatically adjusting speed or perceived resistance based on fore-aft position of the user, without the need for manual input or control) is applicable to exercise machines other than ski simulation machines, including treadmill or other running or walking machines, stair climbing simulators, bicycling simulators, rowing machines, climbing simulators, and the like.

Although Fig. 1 depicts a device inclined upward in the forward direction, it would be possible to provide a machine which could be inclined downward in the forward direction if desired, although this would remove the gravity-power aspect of the configuration.

Although embodiments are described in which speed control is provided by a braked flywheel, other speed control devices can also be used. The flywheel could be braked by a drum-type brake or a pressure plate- or pad-type brake in addition to the circumferential pressure belt brake. The driven roller 116 could be coupled to drive an electric generator for generating energy, e.g., to be dissipated with variable resistance. The flywheel 17 can be provided with fins, blades, or otherwise configured to be resisted by air resistance.

Although in Fig. 2, two shafts are depicted 31, 35, coupled by a belt 18, it would be possible to have the clutches 20a, 20b coupled directly to the flywheel shaft 31, or otherwise to provide only a single shaft. Although it is preferred to use the same resistance mechanism (e.g. flywheel 17) from arm and (backward) leg motion, it would be possible to provide separate resistance devices (such as two flywheels).